

PHYSICS-9

CHAPTER-7

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CHAPTER-7

PROPERTIES OF MATTER

Q-1: What are the important features of kinetic molecular model? How three states of matter can be explained by kinetic molecular model?

KINETIC MOLECULAR MODEL OF MATTER:

The Kinetic Molecular Model of matter has some important features. These are

- Matter is made up of particles called molecules.
- The molecules remain in continuous motion.
- Molecules attract each other.

Matter:

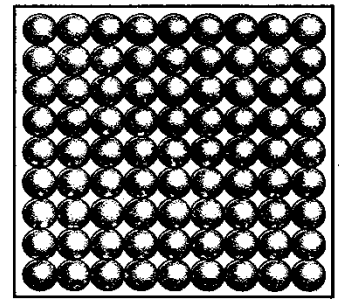
“Anything that has mass and occupies some space is called matter”.

States of Matter:

Kinetic molecular model is used to explain the three states of matter, solid, liquid and gas.

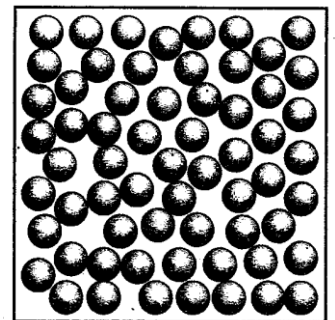
Solids:

- i. Solids have fixed shapes and volume. Such as a stone, metal spoon, pencil, etc.
- ii. Their molecules are held close together such as shown in figure by strong forces of attraction.
- iii. However, they vibrate about their mean positions but do not move from place to place.



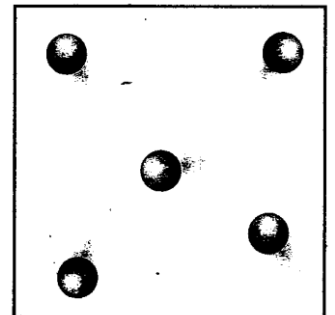
Liquids:

- i. The distances between the molecules of a liquid are more than in solids. Thus, attractive forces between them are weaker.
- ii. Like solids, molecules of a liquid also vibrate about their mean position but are not rigidly held with each other.
- iii. Due to the weaker attractive forces, they can slide over one another. Thus, the liquid can flow.
- iv. The volume of a certain liquid remains the same but because it can flow hence, it attains the shape of a container to which it is put.



Gases:

- i. Gases have no fixed shape or volume such as air.
- ii. They can be filled in any container of any shape.
- iii. Their molecules have random motion and move with very high velocities.
- iv. In gases, molecules are much farther apart than solids or liquids such as shown in figure.
- v. Thus, gases are much lighter than solids and liquids.
- vi. They can be squeezed into smaller volumes.
- vii. The molecules of a gas are constantly striking the walls of container. Thus, a gas exerts pressure on the walls of container.



Q-2: What is plasma? Explain it as a fourth state of matter?

PLASMA:

“At very high temperature, the collision between atoms and molecules tears off their electrons. Atoms become positive ions. This ionic state of matter is called plasma”.

Formation of Plasma:

The kinetic energy of gas molecules goes on increasing if a gas is heated continuously. This causes the gas molecules to move faster and faster. The collisions between atoms and molecules of the gas become so strong that they tear off the atoms. Atoms lose their electrons and become positive ions. This ionic state of matter is called plasma.

Plasma is also formed in gas discharge tubes when electric current passes through these tubes. Plasma also exists in neon and florescent tubes when they glow.

The Fourth State of Matter:

Plasma is called the fourth state of matter in which gas occurs in its ionic state. Positive ions and electrons get separated in the presence of electric or magnetic fields.

Matter of Universe:

Most of the matter that fills the universe is in plasma state in stars such as our Sun, gases exist in their ionic state.

Importance:

Plasma is highly conducting state of matter. It allows electric current to pass through it.

Q-3: What is meant by density? Explain with example. Write its formula and unit?

DENSITY:

“Mass per unit volume of a substance is called the density”.

Explanation:

Is an iron object heavier than that of wood? Not necessary. It depends upon the quantity of iron and wood you are comparing, e.g. If we take equal volumes of iron and wood, then we can easily declare that iron is heavier than wood.

To know which substance is denser or which is lighter we generally compare the densities of various substances. The density of a substance is the ratio of its mass to that of its volume.

Mathematically:

$$\text{Density} = \frac{\text{mass of a substance}}{\text{volume of that substance}}$$

$$\rho = \frac{m}{V}$$

SI Unit:

SI unit of density is kilogramme per cubic metre (kgm^{-3}).

Method to Calculate Density:

We can calculate the density of a material if we know its mass and its volume.

For Example:

The mass of 5 litre of water is 5 kg. Its density can be calculated by putting the values in equation.

$$\begin{aligned} \text{Since} \quad 1 \text{ litre} &= 10^{-3} \text{ m}^3 \\ 5 \text{ litre} &= 5 \times 10^{-3} \text{ m}^3 \\ \text{Density} &= \frac{\text{mass of a substance}}{\text{volume of that substance}} \end{aligned}$$

Density = $\frac{5 \text{ kg}}{5 \times 10^{-3} \text{ m}^3}$
= 10^3 kgm^{-3}
= 1000 kgm^{-3}

The density of water is 1000 kgm^{-3}

Q-4: Define and explain pressure? Write its formula and SI unit.

PRESSURE:

Pressure is defined as:

“The force acting normally per unit area on the surface of a body is called pressure”

Mathematically:

Pressure = $\frac{\text{Force}}{\text{Area}}$
Or P = $\frac{F}{A}$

Quantity:

Pressure is a scalar quantity.

SI Unit:

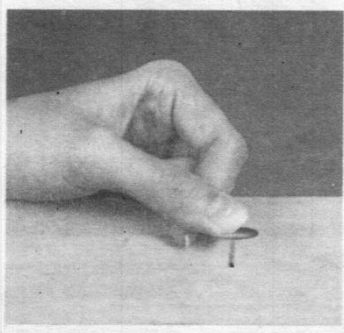
In SI units, the unit of pressure is Nm^{-2} also called Pascal (Pa). Thus

$1 \text{ Nm}^{-2} = 1 \text{ Pa}$

Explanation:

Press a pencil from its ends between the palms. The palm pressing the tip feels much more pain than the palm pressing its blunt end.

We can push a drawing pin into a wooden board by pressing it by our thumb. It is because the force we apply on the drawing pin is confined just at a very small area under its sharp tip. A drawing pin with a blunt tip would be very difficult to push into the board due to the large area of its tip.



In these examples, we find that the effectiveness of a small force is increased if the effective area of the force is reduced. The area of the tip of the pencil or that of the nail is very small and hence increases the effectiveness of the force.

The quantity that depends upon the force and increases with decrease in the area on which force is acting is called pressure.

Q-5: What is meant by atmospheric pressure? What is the direction of atmospheric pressure? Explain with examples.

ATMOSPHERIC PRESSURE:

“The pressure of atmosphere is called atmospheric pressure”.

Atmosphere:

“The earth is surrounded by a cover of air called atmosphere”.

Explanation:

It extends to a few hundred kilometers above sea level. Just as certain sea creatures live at the bottom of ocean, we live at the bottom of a huge ocean of air. Air is a mixture of gases. The density of air in the atmosphere is not uniform. It decreases continuously as we go up.

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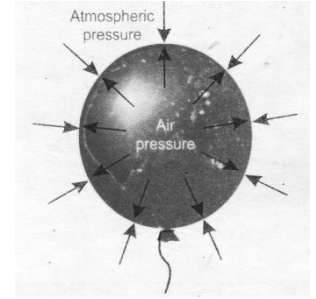
Direction of Atmospheric Pressure:

Atmospheric pressure acts in all directions.

Examples:

Soap bubbles expand till the pressure of air in them is equal to the atmospheric pressure. The soap bubbles so formed have spherical shapes. So the atmospheric pressure acts on a bubble equally in all directions.

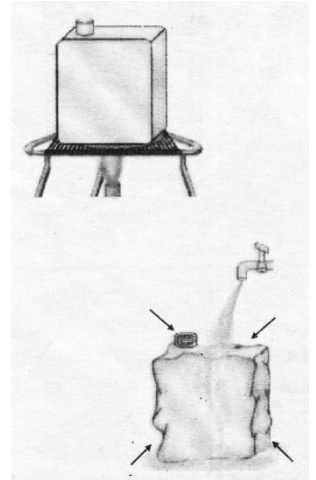
A balloon expands as we fill air into it. Air exerts a pressure inside the balloon which expands till it is equal to atmospheric pressure.



Experiment:

The fact that atmosphere exerts pressure can be explained by a simple experiment.

- Take an empty tin can with a lid.
- Open its cap and put some water in it.
- Place it over flame.
- Wait till water begins to boil and the steam expels air out of the can.
- Remove it from the flame.
- Close the can firmly by its cap.
- Now place the can under tap water. The can will squeeze due to atmospheric pressure.



Reason of Collapsing the Can:

When the can is cooled by tap water, the steam in it condenses, as the steam changes into water it leaves an empty space behind it. This lowers the pressure inside the can as compared to the atmospheric pressure outside the can.

Conclusion:

This experiment shows that atmosphere exerts pressure in all directions.

Remember That:

The fact can also be demonstrated by collapsing of an empty plastic bottle when air is sucked out of it.

Q-6: What is barometer? How atmospheric pressure can be measured with help of it?

BAROMETER:

“The instruments that measure atmospheric pressure are called barometers”.

Construction and Working of Mercury Barometer:

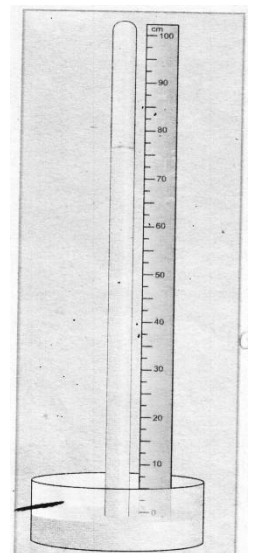
One of the simple barometers is mercury barometer. It consists of a glass tube 1 m long closed at one end. After filling it with mercury, it is inverted in a mercury trough. Mercury in the tube descends and stops at a certain height. The column of mercury held in the tube exerts pressure at its base.

Atmospheric Pressure at Sea Level:

At sea level the height of mercury column above the mercury in the trough is found to be about 76 cm. Pressure exerted by 76 cm of mercury column is nearly $10,1300 \text{ Nm}^{-2}$ equal to atmospheric pressure.

Remember That:

It is common to express atmospheric pressure in terms of the height of mercury column. As the atmospheric pressure at a place does not remains constant, hence, the height of mercury column also varies with atmospheric pressure.



Height of Water Barometer:

Mercury is 13.6 times denser than water. Atmospheric pressure can hold vertical column of water about 13.6 times the height of mercury column at a place. Thus, at sea level, vertical height of water column would be $0.76\text{ m} \times 13.6 = 10.34\text{ m}$. thus, a glass tube more than 10 m long is required to make water barometer.

Q-7: Discuss the variation of atmospheric pressure with altitude? Explain the effects of variation in atmospheric pressure on weather?

VARIATION IN ATMOSPHERIC PRESSURE:

The atmospheric pressure decreases as we go up.

Explanation:

The atmospheric pressure on mountains is lower than at sea level. At a height of about 30 km the atmospheric pressure becomes only 7 mm of mercury which approximately 1000 Pa. it would become zero at an altitude where there is no air.

Note: We can determine the altitude of a place by knowing the atmospheric pressure at that place.

Effects of Temperature on Atmospheric Pressure:

Atmospheric pressure also changes with the change in temperature.

- i. On a hot day, air above the earth becomes hot and expands. This causes a fall of atmospheric pressure in that region.
- ii. On the other hand during cold chilly nights, air above the earth cools down. This causes an increase in atmospheric pressure.

Effects of Atmospheric Pressure on Weather:

The changes in atmospheric pressure at a certain place indicate the expected changes in the weather conditions of that place.

For Example:

- i. A gradual and average drop in atmospheric pressure means a low pressure in a neighboring locality.
- ii. Minor but rapid fall in atmospheric pressure indicates a windy and showery condition in the nearby region.
- iii. A decrease in atmospheric pressure is accompanied by breeze and rain.
- iv. Whereas a sudden fall in atmospheric pressure often followed by a storm, rain and typhoon to occur in few hour time.

On the Other Hand:

- i. An increasing atmospheric pressure with a decline later on predicts an intense weather conditions.
- ii. A gradual large increase in the atmospheric pressure indicated a long spell of pleasant weather.
- iii. A rapid increase in atmospheric pressure means that it will soon be followed by a decrease in the atmospheric pressure indicating poor weather ahead.

Q-8: Is liquid exerts pressure? If yes then derive a formula to measure liquid pressure.

LIQUID PRESSURE:

“Liquid exerts pressure, the pressure of a liquid acts in all directions”.

Pressure Sensor:

“A device that measures liquid pressure is called pressure sensor”.

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Dependence of Liquid Pressure:

If we take a pressure sensor inside a liquid, then the pressure of the liquid varies with the depth of sensor, i.e. liquid pressure depends on depth.

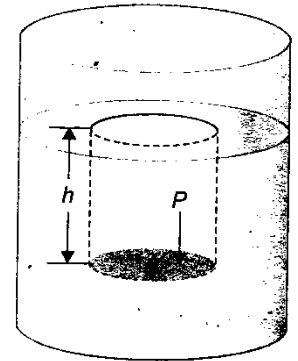
Explanation:

Consider a surface of area A in a liquid at depth h . The length of the cylinder of liquid over this surface will be h . The force acting on this surface will be the weight w of the liquid above this surface, if ρ is the density of the liquid above this surface and m is mass of liquid above the surface, then

$$\begin{aligned} P &= \frac{F}{A} \\ &= \frac{mg}{A} & \because F = w = mg \\ &= \frac{V\rho g}{A} & \because m = V\rho \\ &= \frac{Ah\rho g}{A} & \because V = Ah \end{aligned}$$

$$\text{Liquid pressure at depth } h = P = \rho gh \quad \dots\dots\dots (1)$$

Equation (1) gives the pressure at a depth h in a liquid of density ρ . It shows that pressure in a liquid increase with depth.



Q-9: State and explain Pascal's law. Give few applications of Pascal's law.

PASCAL'S LAW:

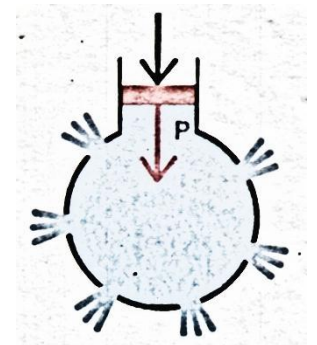
“Pressure applied at any point of a liquid enclosed in a container, is transmitted without loss to all other parts of the liquid”.

Explanation:

An external force applied on the surface of a liquid increases the liquid pressure at the surface of the liquid. This increase in liquid pressure is transmitted equally in all directions and to the walls of the container in which it is filled. This result is called Pascal's law.

Experiment:

It can be demonstrated with the help of a glass vessel having holes all over its surface. Fill it with water. Push the piston. The water rushes out of the holes in the vessel with the same pressure. The force applied on the piston exerts pressure on water. This pressure is transmitted equally throughout the liquid in all directions.



Importance:

In general, this law holds good for fluids both for liquids as well as gases.

Applications of Pascal's Law:

Pascal's law finds numerous applications in our daily life such as

- i. Automobiles
- ii. Hydraulic brake system
- iii. Hydraulic press
- iv. Hydraulic jack
- v. Hydraulic machine

Q-10: Describe the construction and working of hydraulic press.

HYDRAULIC PRESS:

Hydraulic press is a machine which works on Pascal's law.

Construction:

It consists of two cylinders of different cross-sectional areas. They are fitted with pistons of cross-sectional areas a and A .

Working:

The object to be compressed is placed over the piston of large cross-sectional area A . The force F_1 is applied on the piston of small cross-sectional area a . The pressure P produced by small piston is transmitted equally to the large piston and a force F_2 acts on A which is much larger than F_1 .

Pressure on piston of small area a is given by

$$P = \frac{F_1}{a}$$

Apply Pascal's law, the pressure on large piston of area A will be the same as on small piston of area a .

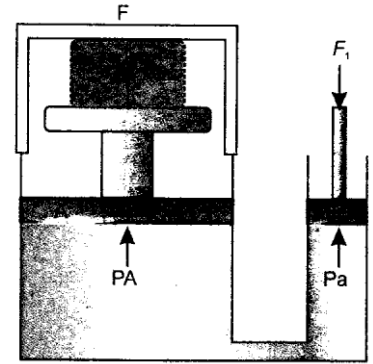
$$P = \frac{F_2}{A}$$

Comparing the above equations, we get.

$$\frac{F_2}{A} = \frac{F_1}{a}$$

$$\frac{F_2}{F_1} = \frac{A}{a}$$

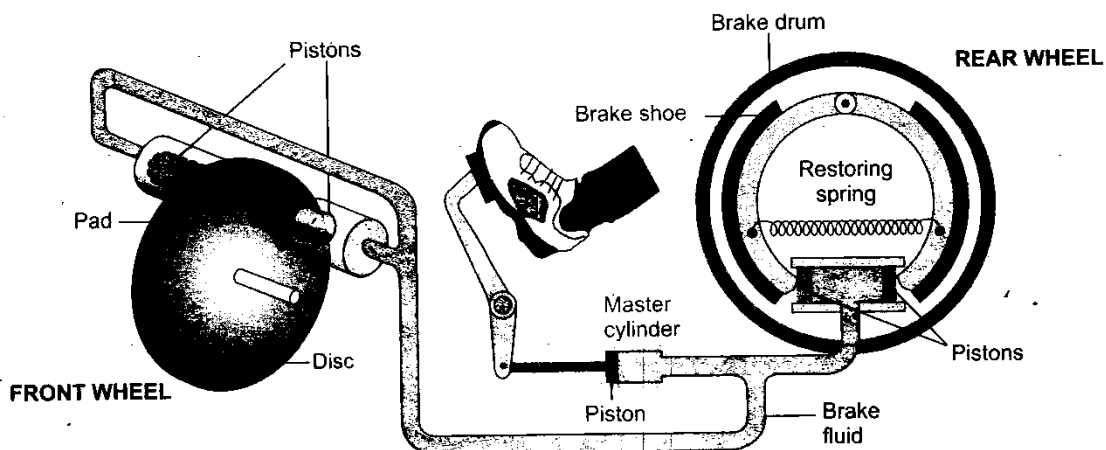
Since the ratio A/a is greater than 1, hence the force F_2 that acts on the larger piston is greater than the force F_1 acting on the smaller piston. Hydraulic systems working in this way are known as force multipliers.

**Q-11: Describe the construction and working of braking system in vehicles.****BRAKING SYSTEM IN VEHICLES:**

The braking system of cars buses, etc. also works on Pascal's law. The hydraulic brakes allow equal pressure to be transmitted throughout the liquid.

Construction and Working:

- When brake pedal is pushed, it exerts a force on the master cylinder, which increases the liquid pressure in it.
- The liquid pressure is transmitted equally through the liquid in the metal pipes to all the pistons of other cylinders.
- Due to the increase liquid pressures, the piston in the cylinders move outward pressing the brake pads with the brake drums.
- The force of friction between the brake pads and the brake drums stops the wheels.



Q-12: State and explain Archimedes Principle? Derive an expression for the upthrust acting on an object immersed in liquid.

ARCHIMEDES PRINCIPLE:

Archimedes principle states that:

“When an object is totally or partially immersed in a liquid, an upthrust acts on it, equal to the weight of the liquid it displaces”.

Upthrust:

“The upward force acting on the object is called the upthrust of the liquid”.

Explanation:

More than two thousand years ago, the Greek scientist, Archimedes noticed that there is an upward force (upthrust) which acts on an object kept inside a liquid. As results an apparent loss of weight is observed in the object.

Examples:

- An air filled balloon immediately shoots up to the surface when released under water.
- The same would happen if a piece of wood is released under water.
- We might have noticed that mug filled with water feels light under water but feels heavy as soon as we take it out of water.

Mathematical Explanation:

Consider a solid cylinder of cross-sectional area A and height h immersed in a liquid. Let h_1 and h_2 be the depths of the top and bottom faces of the cylinder respectively from the surface of the liquid.

Then $h_2 - h_1 = h$

If P_1 and P_2 are the liquid pressures at depths h_1 and h_2 respectively and ρ is its density then according to equation.

$$P_1 = \rho g h_1$$

$$P_2 = \rho g h_2$$

Let the force F_1 is exerted at the cylinder top by the liquid due to pressure P_1 and the force F_2 is exerted at the bottom of the cylinder by the liquid due to P_2

$$F_1 = P_1 A = \rho g h_1 A$$

$$F_2 = P_2 A = \rho g h_2 A$$

Since F_1 and F_2 are acting on the opposite faces of the cylinder. Therefore, the net force F will be $F_2 - F_1$ in the direction of F_2 . This net force F on the cylinder is called the upthrust of the liquid.

$$F_2 - F_1 = \rho g h_2 A - \rho g h_1 A$$

$$= \rho g A (h_2 - h_1)$$

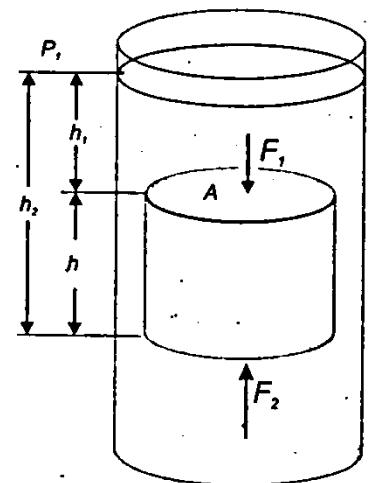
$$= \rho g A h$$

$$= \rho g V$$

$$= m g$$

$$= w$$

$$\text{Upthrust of liquid} = \text{Weight of the liquid displaced}$$



Conclusion:

Equation shows that the upthrust acts on the body immersed in a liquid and is equal to the weight of liquid displaced, which is Archimedes Principle.

Q-13: How density of an object can be found out by Archimedes principle? Explain.

DENSITY OF AN OBJECT:

Archimedes principle is also helpful to determine the density of an object.

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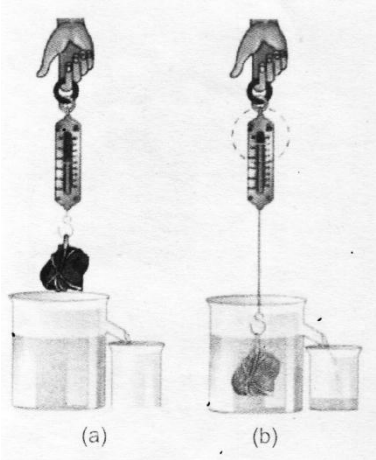
“The ratio in the weights of a body with an equal volume of liquid is the same as in their densities”.

Let	Density of the object	=	D
	Density of the liquid	=	ρ
	Weight of the object in air	=	w ₁
	Weight of the object in liquid	=	w ₂
	Weight of equal volume of liquid	=	w = w ₁ – w ₂

According to Archimedes principle, w₂ is less than its actual weight w₁ by an amount w.

Since

$$\frac{D}{\rho} = \frac{w_1}{w}$$
$$D = \frac{w_1}{w} \times \rho$$
$$D = \frac{w_1}{w_1 - w_2} \times \rho \dots\dots\dots (1)$$



Thus finding the weight of the solid in air w₁ and its weight in water w₂, we can calculate the density of the solid by using equation (1).

Q-14: What is the principle of floatation? Briefly explain it.

PRINCIPLE OF FLOATATION:

It states that:
“A floating object displaces a fluid having weight equal to the weight of the object”.

Object Sinks:

An object sinks if its weight is greater than the upthrust acting on it.

Object Floats:

An object floats if its weight is equal or less than the upthrust.

Explanation:

When an object floats in a fluid, the upthrust acting on it is equal to the weight of the object. In case of floating object, the object may be partially immersed. The upthrust is always equal to the weight of the fluid displaced by the object. This is the principle of floatation.

Importance of Principle:

Archimedes principle is applicable on liquid as well as gases. We find numerous applications of this principle in our daily life.

Q-15: Write a note on ships and submarines?

FLOATATION OF WOODEN BLOCK:

A wooden block floats on water. It is because the weight of an equal volume of water is greater than the weight of the block. According to the principle of floatation, a body floats if it displaces water equal to the weight of the body when it is partially or completely immersed in water.

Ships and Boats:

Ships and boats are designed on the same principle of floatation. They carry passengers and goods over water. It would sink in water if its weight including the weight of its passengers and goods become greater than the upthrust of water.

Submarines:

A submarine can travel over as well as under water. It also works on the principle of floatation. It floats over water when the weight of water equal to its volume is greater than its weight. Under this condition, it is similar to a ship and remains partially above water level. It has a system of tanks which can be filled with and emptied from seawater.

عالم سے ایک گھنٹہ کی گفتگو دس برس کے مطالعہ سے زیادہ مفید ہے۔

When these tanks are filled with seawater, the weight of the submarine increases. As soon as its weight becomes greater than the upthrust, it dives into water and remains under water. To come up on the surface the tanks are emptied from seawater.

Q-16: What is meant by elasticity? Explain with example.

ELASTICITY:

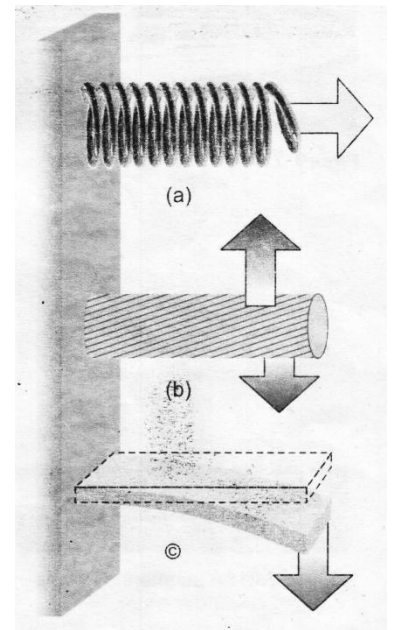
“The property of a body to restore its original size and shape as the deforming force ceases to act is called elasticity”.

Deforming Force:

“The applied force that changes shape, length or volume of substance is called deforming force”.

Explanation:

The length of a rubber band increases on stretching it. Similarly, the pointer of a spring balance is lowered when a body is suspended from it. It is because the length of the spring inside the balance increases depending upon the weight of the suspended body. In most of the cases the body returns to its original size and shape as soon as the deforming force is removed.



Q-17: Write a brief note on stress and strain?

STRESS:

Stress is related to the force producing deformation. It is defined as:

“The force acting on unit area at the surface of a body is called stress”.

Mathematically:

$$\begin{aligned} \text{Stress} &= \frac{\text{Force}}{\text{Area}} \\ \text{Stress} &= \frac{F}{A} \end{aligned}$$

SI Unit:

In SI, the unit of stress is Newton per square metre (Nm^{-2})

STRAIN:

“When stress acts on a body, it may change its length, volume, or shape. A comparison of such a change caused by the stress with the original length, volume or shape is called as strain”.

Tensile Strain:

“If stress produces a change in the length of an object then the strain is called tensile strain”.

Mathematically:

$$\begin{aligned} \text{Tensile Strain} &= \frac{\text{Change in length}}{\text{Original Length}} \\ \text{Tensile Strain} &= \frac{\Delta L}{L_0} \end{aligned}$$

SI Unit:

Strain has no unit as it is simply a ratio between two similar quantities.

Q-18: State and explain Hooks law?

HOOKE'S LAW:

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It has been observed that deformation in length, volume or shape of a body depends upon the stress acting on the body. Hooke’s law states that:

“The strain produced in a body by the stress applied to it is directly proportional to the stress within the elastic limit of the body”.

Mathematically:

Or

stress ∝ strain

stress = constant x strain

Or

$\frac{\text{stress}}{\text{strain}} = \text{constant}$

Applications of Hook’s Law:

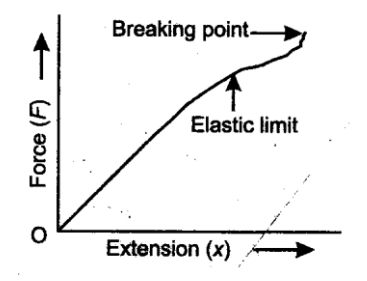
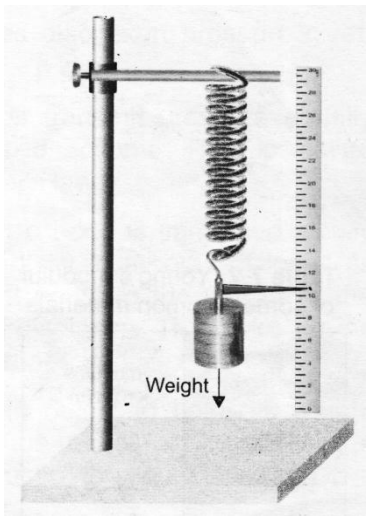
Hooke’s law is applicable to all kinds of deformation and all types of matter i.e. solids, liquids or gases within certain limit. This limit tells the maximum stress that can be safely applied on a body without causing permanent deformation in its length volume or shape.

Elastic Limiting:

“It is a limit within which a body recovers its original length, volume or shape after the deforming force is removed”.

Remember That:

When a stress crosses this limit, called the elastic limit, a body is permanently deformed and is unable to restore its original state after the stress is removed.



Q-19: Define Young’s Modulus. Derive its expression?

YOUNG’S MODULUS:

“The ratio of stress to tensile strain is called Young’s modulus”.

Mathematically:

Consider a long bar of length L_0 and cross-sectional area A . Let an external force F equal to the weight w stretches it such that the stretched length become L . Let $\Delta L = L - L_0$ be the change in length of the rod. According to Hooke’s law, the ratio of this stress to tensile strain is constant within the elastic limit of the body.

Young’s Modulus = $Y = \frac{\text{stress}}{\text{Tensile strain}}$

Where

Stress = $\frac{F}{A}$

Tensile Strain = $\frac{\Delta L}{L_0}$

$Y = \frac{\frac{F}{A}}{\frac{\Delta L}{L_0}}$

$= \frac{F}{A} \times \frac{L_0}{\Delta L}$

$Y = \frac{F L_0}{A \Delta L} \dots\dots\dots (1)$

SI Unit:

SI unit of Young’s modulus is Newton per square metre (Nm^{-2}).

Table:

Young’s modulus of some common materials, are given in the table.

جس نے طلب علم میں وفات پائی وہ شہید مرا۔ (محمد ﷺ)

Materials	Young's Modulus (Nm ⁻²)
Aluminum	70 x 10 ⁹
Bone	0.02 x 10 ⁹
Brass	91 x 10 ⁹
Copper	110 x 10 ⁹
Diamond	1120 x 10 ⁹
Glass	60 x 10 ⁹
Iron	190 x 10 ⁹
Lead	16 x 10 ⁹
Nickel	200 x 10 ⁹
Rubber	0.0007 x 10 ⁹
Steel	200 x 10 ⁹
Tungsten	400 x 10 ⁹
Wood (parallel gain)	10 x 10 ⁹
Wood (perpendicular gain)	1 x 10 ⁹

DO YOU KNOW

1. Give density of various substances?

Ans:

Substances	Density (kgm ⁻³)
Air	1.3
Foam	89
Petrol	800
Cooking oil	920
Ice	920
Water	1000
Glass	2500
Aluminum	2700
Iron	7900
Copper	8900
Lead	11200
Mercury	13600
Gold	19300
Platinum	21500

2. Give relation between units of volume and density.

Ans:

1 m³ = 1000 litre
1 litre = 10⁻³ m³
1 cm³ = 10⁻⁶ m³
1000 kgm⁻³ = 1 gcm⁻³

3. What do you know about Earth's atmosphere?

Ans: Earth's atmosphere extends upward about a few hundred kilometres with continuously decreasing density. Nearly half of its mass is between sea level and 10 km. Up to 30 km from sea level contains about 99 % of the mass of the atmosphere. The air becomes thinner and thinner as we go up.

4. How vacuum cleaner works?

Ans: The fan in a vacuum cleaner lowers air pressure in its bucket. The atmospheric air rushes into it carrying dust and dirt with it through its intake port. The dust and dirt particles are blocked by the filter while air escapes out.
5. How a straw works to push a liquid up?

Ans: When air is suck through straw with its other end dipped in a liquid, the air pressure in the straw decreases. This causes the atmospheric pressure to push the liquid up the straw.
6. What do you know about working of syringe?

Ans: The piston of the syringe is pulled out. This lowers the pressure in the cylinder. The liquid from the bottle enters into the piston through the needle.
7. What do you know about hydrometer and acid meter?

Ans: **Hydrometer** is a glass tube with a scale marked on its stem and heavy weight in the bottom. It is partially immersed in a fluid, the density of which is to be measured.

One type of hydrometer is used to measure the concentration of acid in a battery. It is called **acid meter**.

MULTIPLE CHOICE EXERCISE

Q-7.1: Multiple Choice Questions:

1. In which of the following state molecules do not leave their position?

a) solid
b) liquid
c) gas
d) plasma
2. Which of the substances is the lightest one?

a) copper
b) mercury
c) aluminum
d) lead
3. SI unit of pressure is Pascal, which is equal to

a) 10^4 Nm^{-2}
b) 1 Nm^{-2}
c) 10^2 Nm^{-2}
d) 10^3 Nm^{-2}
4. What should be the approximate length of a glass tube to construct a water barometer?

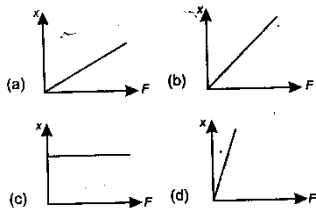
a) 0.5 m
b) 1 m
c) 2.5 m
d) 11 m
5. According to Archimedes principle, upthrust is equal to

a) weight of displaced liquid
b) volume of displaced liquid
c) mass of displaced liquid
d) none of these
6. The density of a substance can be found with the help of

a) Pascal's law
b) Hook's law
c) Archimedes principle
d) Principle of floatation
7. According to Hook's law

a) Stress x strain = constant
b) stress / strain = constant
c) strain / stress = constant
d) stress = strain
- The following force-extension graph of spring are drawn on the same scale. Answer the questions given below from (viii) to (x)
8. Which graph does not obey Hook's law?

a)
b)
c)
d)



9. Which graph gives the smallest value of spring constant?
a) b) c) d)
10. Which graph gives the largest value of spring constant?
a) b) c) d)

CHAPTER-7			9 th PHYSICS MCQS ANSWERS						
1	2	3	4	5	6	7	8	9	10
a	c	b	d	a	c	b	c	d	a

REMAINING EXERCISE

- Q-7.2: How kinetic molecular model of matter is helpful in differentiating various states of matter?
Ans: See Notes Q-1
- Q-7.3: Does there exist, a fourth state of matter? What is that?
Ans: See Notes Q-2
- Q-7.4: What is meant by density? What is SI unit?
Ans: See Notes Q-3
- Q-7.5: Can we use hydrometer to measure the density of milk?
Ans: Yes, hydrometer is an instrument which is used to measure density of milk or any other liquid, it is partially immersed in a fluid, the density of which is to be measured. Hence we can say hydrometer (lactometer) is used to measure the density of milk.
- Q-7.6: Define the term pressure?
Ans: See Notes Q-4
- Q-7.7: Show that atmosphere exert, pressure?
Ans: See Notes Q-5
- Q-7.8: It is easy to fill air in a balloon but it is very difficult to remove air from a glass bottle. Why?
Ans: The air in the balloon is compressed air. It can easily be removed because pressure inside the balloon is greater than the atmospheric pressure. But the air inside a glass bottle is already at atmospheric pressure, so it cannot be removed easily.
- Q-7.9: What is barometer?
Ans: See Notes Q-6
- Q-7.10: Why water is not suitable to be used in a barometer?
Ans: Mercury is 13.6 times denser than water. Atmospheric pressure can hold vertical column of water about 13.6 times the height of mercury column at a place. Thus, at sea level, vertical height of water column would be $0.76\text{ m} \times 13.6 = 10.34\text{ m}$. thus, a glass tube more than 10 m long is required to make water barometer. It is difficult to manage and handle. Thus water is not suitable to be used in a barometer.
- Q-7.11: What makes a sucker pressed on a smooth wall sticks to it?
Ans: When a sucker is pressed on a smooth wall, air inside the sucker is removed. Now the sucker remains stick on the wall due to atmospheric pressure outside.
- Q-7.12: Why does the atmospheric pressure vary with height?

Ans: See Notes Q-7

Q-7.13: What does it mean when the atmospheric pressure at a place fall suddenly?

Ans: See Notes Q-7

Q-7.14: What changes are expected in weather if the barometer reading shows a sudden increase?

Ans: See Notes Q-7

Q-7.15: State Pascal’s law.

Ans: See Notes Q-9

Q-7.16: Explain the working of hydraulic press?

Ans: See Notes Q-10

Q-7.17: What is meant by elasticity?

Ans: See Notes Q-16

Q-7.18: State Archimedes Principle.

Ans: See Notes Q-12

Q-7.19: What is upthrust? Explain the principle of floatation.

Ans: See Notes Q-12, 14

Q-7.20: Explain how a submarine moves up the water surface and down into water?

Ans: See Notes Q-15

Q-7.21: Why does a piece of stone sink in water but a ship with a huge weight floats?

Ans: A piece of stone sinks in water because the weight of water under it equal to its volume is less than its weight. On the other hand, a ship floats over water because the weight of water equal to its volume is greater than its weight.

Q-7.22: What is hook’s law? What is meant by elastic limit?

Ans: See Notes Q-16

Q-7.23: Take a rubber band. Construct a balance of your own using a rubber band. Check the accuracy by weighing various objects.

Ans: Take a rubber band and construct a balance with it. Then measure the weight of various objects to check its accuracy. First take a lead pencil and measure its weight then take a small eraser on it and measure its weight. Both the objects have less weight than the elastic limit of rubber band. That is why they could be measured easily.

But when you take a heavy stone and placed it in the balance. As this mass was beyond the elastic limit of the rubber band. Rubber band was broken and weight of the stone could not be measured.

EXAMPLES

Example 7.1: The mass of 200 cm³ of stone is 500 g. Find its density.

Sol:

Mass

= m

= 500 g

= $\frac{500}{1000}$

= 0.5 kg

Volume

= V

= 200 cm³

= $\frac{200}{100 \times 100 \times 100}$

= 2 x 10⁻⁴ m³

Density

= ρ

= ?

Now

Density

=

$\frac{\text{mass}}{\text{volume}}$

اس علم کی تلاش کرو جو موت کے وقت اور روزِ آخرت تمہارے کام آئے۔ (حضرت امام غزالیؒ)

$$\begin{aligned}
 &= \frac{0.5}{2 \times 10^{-4}} \\
 &= 0.25 \times 10^4 \text{ kgm}^{-3} \\
 &= 2.5 \times 10^3 \text{ kgm}^{-3}
 \end{aligned}$$

Example 7.2: In a hydraulic press, a force of 100 N is applied on the piston of a pump of a cross-sectional area 0.01 m². Find the force that compresses a cotton bale places on larger piston of cross-sectional area 1 m².

Sol: Force on small piston = F₁ = 100 N
 Area of small piston = a = 0.01 m²
 Area of large piston = A = 1 m²
 Force on large piston = F₂ = ?
 Now by Pascal's law

$$\begin{aligned}
 \frac{F_2}{A} &= \frac{F_1}{a} \\
 \frac{F_2}{1} &= \frac{100}{0.01} \\
 F_2 &= 10000 \text{ N}
 \end{aligned}$$

Example 7.3: A wooden cube of sides 10 cm has been dipped completely in water. Calculate the upthrust if water acting on it.

Sol: Length of side = L = 10 cm = $\frac{10}{100}$ = 0.1 m
 Gravitational acceleration = g = 10 ms⁻²
 Density of water = ρ = 1000 kgm⁻³
 Upthrust = F = ?

Firstly:

$$\begin{aligned}
 \text{Volume of cube} &= (\text{Length})^3 \\
 &= (0.1)^3 \\
 V &= 0.001 \text{ m}^3
 \end{aligned}$$

Now

$$\begin{aligned}
 \text{Upthrust} &= \rho g V \\
 &= (1000)(10)(0.001) \\
 F &= 10 \text{ N}
 \end{aligned}$$

Example 7.4: The weight of a metal spoon in air is 0.48 N. Its weight in water is 0.42 N. Find its density.

Sol: Weight of Spoon in air = w₁ = 0.48 N
 Weight of Spoon in water = w₂ = 0.42 N
 Density of water = ρ = 1000 kgm⁻³
 Density of spoon = D = ?

Now:

$$\begin{aligned}
 D &= \frac{w_1}{w_1 - w_2} \times \rho \\
 &= \frac{0.48}{0.48 - 0.42} \times 1000 \\
 &= \frac{0.48}{0.06} \times 1000 \\
 \text{Density of spoon} &= 8000 \text{ kgm}^{-3}
 \end{aligned}$$

Example 7.5: An empty meteorological balloon weighs 80N. It is filled with 10 cubic metres of hydrogen. How much maximum contents the balloon can lift besides its own weight? The density of hydrogen is 0.09 kgm⁻³ and the density of air is 1.3 kgm⁻³.

تمام خوبیوں کا مجموعہ علم سیکھنا، عمل کرنا اور پھر اوروں کو سکھانا ہے۔ (حضرت عبدالقادر جیلانیؒ)

Sol:

Volume of hydrogen	= V	= 10 m ³
Density of hydrogen	= ρ ₁	= 0.09 kgm ⁻³
Density of air	= ρ ₂	= 1.3 kg m ⁻³
Weight of the balloon	= w ₁	= 80 N
Weight of hydrogen	= w ₂	= ?
Weight of the contents	= w ₃	= ?

Firstly:

Upthrust	= F	= Weight of air displaced
		= ρ ₂ g V
		= 1.3 x 10 x 10
		= 130 N

Secondly:

Weight of hydrogen	= w ₂	= ρ ₁ g V
		= 0.09 x 10 x 10
		= 9 N

Lastly:

To lift the content, the total weight of the balloon should not exceed by upthrust F.

Total weight lifted	= F	= w ₁ + w ₂ + w ₃
	130	= 80 + 9 + w ₃
	w ₃	= 130 – 80 – 9
		= 41 N

Thus, the maximum weight of 41 N can be lifted by the balloon in addition to its own weight.

Example 7.6: A barge 40 metre long and 8 metre broad, whose sides are vertical, floats partially loaded in water. If 125000 N of cargo is added, how many metres will it sink?

Sol:

Length of barge	= L	= 40 m
Width of barge	= W	= 8 m
Weight of cargo	= w	= 125000 N
Density of water	= ρ	= 1000 kgm ⁻³
Depth of barge	= h	= ?

Firstly:

Area of barge	= A	= L x W
		= 40 x 8
	A	= 320 m ²

Now, increased upthrust F of water must be equal to the additional load. i.e.

F	= ρ g V	
w	= ρ g A h	∴ F = w
h	= $\frac{w}{\rho g A}$	V = Ah
	= $\frac{125000}{1000 \times 10 \times 320}$	
	= 0.04 m	
	= 0.04 x 100 cm	
h	= 4 cm	

Thus the barge will sink 4 cm in water on adding 125000 N cargo.

Example 7.7: A steel wire 1 m long and cross-sectional area 5 x 10⁻⁵ m² is stretched through 1 mm by a force of 10,000 N. Find the Young’s modulus of the wire.

Sol:

Force	= F	= 10,000 N = 10 ⁴ N
Length	= L _o	= 1 m
Extension	= ΔL	= 1 mm = 1 x 10 ⁻³ m

$$\begin{aligned} \text{Cross-sectional Area} &= A = 5 \times 10^{-5} \text{ m}^2 \\ \text{Young's modulus} &= Y = ? \\ \text{Now} \end{aligned}$$

$$\begin{aligned} Y &= \frac{F L_0}{A \Delta L} \\ &= \frac{(10^4) (1)}{(5 \times 10^{-5}) (1 \times 10^{-3})} \\ &= 0.2 \times 10^{4+5+3} \\ &= 2 \times 10^{4+5+3-1} \\ Y &= 2 \times 10^{11} \text{ Nm}^{-2} \end{aligned}$$

Thus young's modulus of steel is $2 \times 10^{11} \text{ Nm}^{-2}$

PROBLEMS

Problem 7.1: A wooden block measuring 40cm x 10cm x 5cm has a mass 850 g. Find the density of wood?

Sol:

$$\begin{aligned} \text{Volume} &= V = 40\text{cm} \times 10\text{cm} \times 5\text{cm} = 2000 \text{ cm}^3 = \frac{2000}{100 \times 100 \times 100} \text{ m}^3 = 0.002 \text{ m}^3 \\ \text{Mass} &= m = 850\text{g} = \frac{850}{1000} \text{ kg} = 0.85 \text{ kg} \\ \text{Density} &= \rho = ? \\ \text{Now} \end{aligned}$$

$$\begin{aligned} \text{Density} &= \frac{\text{mass}}{\text{volume}} \\ \rho &= \frac{0.85}{0.002} \\ \rho &= 425 \text{ kgm}^{-3} \end{aligned}$$

Problem 7.2: How much would be the volume of ice formed by freezing 1 litre of water.

Sol:

$$\begin{aligned} \text{Density of water} &= \rho_1 = 1000 \text{ kgm}^{-3} \\ \text{Density of ice} &= \rho_2 = 920 \text{ kgm}^{-3} \\ \text{Volume of water} &= V_1 = 1 \text{ litre} \\ \text{Volume of ice} &= V_2 = ? \\ \text{Now} \end{aligned}$$

$$\begin{aligned} \text{Mass of ice} &= \text{Mass of water} \\ \rho_2 V_2 &= \rho_1 V_1 \\ 920 \times V_2 &= 1000 \times 1 \\ V_2 &= \frac{1000 \times 1}{920} \\ V_2 &= 1.09 \text{ litre} \end{aligned}$$

Problem 7.3: Calculate the volume of the following objects:

i. An iron sphere of mass 5 kg, the density of iron is 8200 kgm^{-3}

Sol:

$$\begin{aligned} \text{Mass} &= m = 5 \text{ kg} \\ \text{Density} &= \rho = 8200 \text{ kgm}^{-3} \\ \text{Volume} &= V = ? \end{aligned}$$

Now

$$\begin{aligned} \text{Volume} &= \frac{\text{mass}}{\text{density}} \\ &= \frac{5}{8200} \\ V &= 6.1 \times 10^{-4} \text{ m}^3 \end{aligned}$$

ii. 200 g of lead shot having density 11300 kgm^{-3}

ہنر سیکھنے میں ذلت اٹھانا پڑے تو اٹھالو۔ (حضرت بابا فرید الدین گنج شکرؒ)

.....

Mass

= m

= 200 g = $\frac{200}{1000}$ kg = 0.2 kg

Density

= ρ

= 11300 kgm⁻³

Volume

= V

= ?

Now

Volume

=

$\frac{\text{mass}}{\text{density}}$

=

$\frac{0.2}{11300}$

V

=

$1.77 \times 10^{-5} \text{ m}^3$

iii. A gold bar of mass 0.2 kg and the density of gold is 19300 kgm⁻³

Mass

= m

= 0.2 kg

Density

= ρ

= 19300 kgm⁻³

Volume

= V

= ?

Now

Volume

=

$\frac{\text{mass}}{\text{density}}$

=

$\frac{0.2}{19300}$

V

=

$1.04 \times 10^{-5} \text{ m}^3$

Problem 7.4: The density of air is 1.3 kgm⁻³. Find the mass of air in a room measuring 8m x 5m x 4m.

Sol:

Density

= ρ

= 1.3 kgm⁻³

Volume

= V

= 8m x 5m x 4m = 160 m³

Mass

= m

= ?

Now

mass

=

volume × density

=

1.3 x 160

m

=

208 kg

Problem 7.5: A student presses her palm by her thumb with a force of 75 N. How much would be the pressure under her thumb having contact area 1.5 cm²?

Sol:

Force

= F

= 75 N

Area

= A

= $1.5 \text{ cm}^2 = \frac{1.5}{100 \times 100} \text{ m}^2 = 1.5 \times 10^{-4} \text{ m}^2$

Pressure

= P

= ?

Now

P

=

$\frac{F}{A}$

=

$\frac{75}{1.5 \times 10^{-4}}$

=

50×10^4

P

=

$5 \times 10^5 \text{ Nm}^{-2}$

Problem 7.6: The head of a pin is a square of side 10 mm. Find the pressure on it due to a force of 20 N.

Sol:

Length

= L

= 10 mm = $10 \times 10^{-3} \text{ m}$

Force

= F

= 20 N

Pressure

= P

= ?

Firstly:

Area

= (Length)²

= $(10 \times 10^{-3})^2$

جس کا غصہ زیادہ ہے اس کے دوست کم ہیں۔ (حضرت سیدنا علی ہجویریؑ)

$$\begin{aligned}
 &= 100 \times 10^{-6} \\
 &= 10^{-6+2} \text{ m}^2 \\
 A &= 10^{-4} \text{ m}^2 \\
 \text{Now} \\
 P &= \frac{F}{A} \\
 &= \frac{20}{10^{-4}} \\
 &= 20 \times 10^4 \\
 P &= 2 \times 10^5 \text{ Nm}^{-2}
 \end{aligned}$$

Problem 7.7: A uniform rectangular block of wood 20 cm × 7.5 cm × 7.5 cm and of mass 1000g stands on a horizontal surface with its longest edge vertical. Find (i) the pressure exerted by the block on the surface (ii) density of the wood.

Sol:

Mass	= m	= 1000 g = 1 kg
Volume	= V	= 20cm × 7.5cm × 7.5cm
		= 1125 cm ³ = $\frac{1125}{100 \times 100 \times 100} \text{ m}^3 = 1.125 \times 10^{-3} \text{ m}^3$
Area	= A	= 7.5cm × 7.5cm
		= 56.25 cm ² = $\frac{56.25}{100 \times 100} \text{ m}^2 = 5.625 \times 10^{-3} \text{ m}^2$
Pressure	= P	= ?
Density	= ρ	= ?

Firstly:

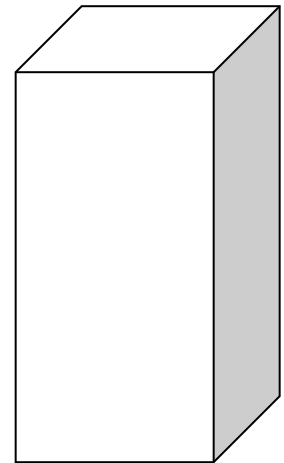
$$\begin{aligned}
 \text{Force} = F &= w = mg \\
 &= 1 \times 10 \\
 &= 10 \text{ N}
 \end{aligned}$$

Now

$$\begin{aligned}
 P &= \frac{F}{A} \\
 &= \frac{10}{5.625 \times 10^{-3}} \\
 &= 1.778 \times 10^3 \\
 &= 1778 \text{ Nm}^{-2}
 \end{aligned}$$

Also

$$\begin{aligned}
 \text{Density} &= \frac{\text{mass}}{\text{volume}} \\
 &= \frac{1}{1.125 \times 10^{-3}} \\
 &= 0.889 \times 10^3 \\
 &= 889 \text{ kgm}^{-3}
 \end{aligned}$$



Problem 7.8: A cube of glass of 5 cm side and mass 306 g, has a cavity inside it. If the density of glass is 2.55 gcm⁻³. Find the volume of the cavity.

Sol:

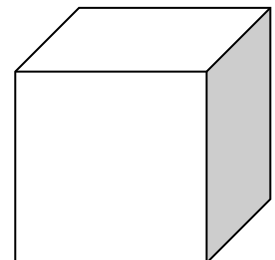
Side of cube	= L	= 5 cm
Mass of cube	= m	= 306 g
Density of glass	= ρ	= 2.55 gcm ⁻³
Volume of cavity	= V	= ?

Firstly:

$$\begin{aligned}
 \text{Volume of cube} &= 5\text{cm} \times 5\text{cm} \times 5\text{cm} \\
 &= 125 \text{ cm}^3
 \end{aligned}$$

Secondly:

$$\text{Volume of glass} = \frac{\text{mass}}{\text{density}}$$



جسے خدا ذلیل کرنا چاہے وہ دولت کی تلاش میں لگ جاتا ہے۔ (حضرت حسن بصریؒ)

= 306 / 2.55
= 120 cm³

Lastly:

Volume of cavity = 125cm³ – 120cm³
= 5 cm³

Problem 7.9: An object has weight 18 N in air. Its weight is found to be 11.4 N when immersed in water. Calculate its density. Can you guess the material of the object?

Sol: Weight of object in air = w₁ = 18 N
Weight of object in water = w₂ = 11.4 N
Density of water = ρ = 1000 kgm⁻³
Density of object = D = ?

Now:

D = (w₁ / (w₁ - w₂)) x ρ
= (18 / (18 - 11.4)) x 1000
= (18 / 6.6) x 1000
Density of object = 2727 kgm⁻³

The density of the object shows that it is made up of Aluminum.

Problem 7.10: A solid block of wood of density 0.6 gcm⁻³ weighs 3.06 N in air, Determine (a) volume of the block (b) the volume of the block immersed when placed freely in a liquid of density 0.9 gcm⁻³?

Sol: Density of wood = ρ₁ = 0.6 gcm⁻³
Density of liquid = ρ₂ = 0.9 gcm⁻³
Weight of the wooden block = w = 3.06 N
Volume of the block = V₁ = ?
Volume of the block when immersed in liquid = V₂ = ?

Firstly:

w = mg
3.06 = m x 10
m = (3.06 / 10)
= 0.306 kg
= 0.306 x 1000 g
= 306 g

Now

Volume of the block = (mass / density)
= (306 / 0.6)
= 510 cm³

And

Volume of the block when immersed in liquid = (mass / density)
= (306 / 0.9)
= 340 cm³

کسی سوال کا جواب اگر معلوم نہ ہو تو غلط جواب دینے سے بہتر ہے خاموش رہو۔ (حضرت ابن عربیؒ)

Problem 7.11: The diameter of the piston of a hydraulic press is 30 cm. How much force is required to lift a car weighing 20000 N on its piston if the diameter of the piston of the pump is 3 cm?

Sol: Diameter of larger piston = $D = 30 \text{ cm} = 30 \times 10^{-2} \text{ m}$
 Diameter of smaller piston = $d = 3 \text{ cm} = 3 \times 10^{-2} \text{ m}$
 Force on larger piston = $F_2 = w = 20,000 \text{ N}$
 Force on smaller piston = $F_1 = ?$

Firstly: Area of larger piston

$$\begin{aligned} A &= \frac{\pi D^2}{4} \\ &= \frac{(3.14)(30 \times 10^{-2})^2}{4} \\ &= \frac{(3.14)(900 \times 10^{-4})}{4} \\ A &= 706.5 \times 10^{-4} \text{ m}^2 \end{aligned}$$

Secondly: Area of smaller piston

$$\begin{aligned} a &= \frac{\pi d^2}{4} \\ &= \frac{(3.14)(3 \times 10^{-2})^2}{4} \\ &= \frac{(3.14)(9 \times 10^{-4})}{4} \\ a &= 7.065 \times 10^{-4} \text{ m}^2 \end{aligned}$$

Lastly: Now by Pascal's law

$$\begin{aligned} \frac{F_1}{a} &= \frac{F_2}{A} \\ \frac{F_1}{7.065 \times 10^{-4}} &= \frac{20000}{706.5 \times 10^{-4}} \\ F_1 &= \frac{20000 \times 7.065 \times 10^{-4}}{706.5 \times 10^{-4}} \\ &= 200 \text{ N} \end{aligned}$$

Problem 7.12: A steel wire of cross-sectional area $2 \times 10^{-5} \text{ m}^2$ is stretched through 2 mm by a force of 4000 N. Find the young's modulus of the wire. The length of wire is 2 m.

Sol: Force = $F = 4000 \text{ N}$
 Length = $L_0 = 2 \text{ m}$
 Extension = $\Delta L = 2 \text{ mm} = 2 \times 10^{-3} \text{ m}$
 Cross-sectional Area = $A = 2 \times 10^{-5} \text{ m}^2$
 Young's modulus = $Y = ?$
 Now

$$\begin{aligned} Y &= \frac{F L_0}{A \Delta L} \\ Y &= \frac{(4000)(2)}{(2 \times 10^{-5})(2 \times 10^{-3})} \\ &= 2000 \times 10^{5+3} \\ &= 2 \times 10^{5+3+3} \\ Y &= 2 \times 10^{11} \text{ Nm}^{-2} \end{aligned}$$

Thus young's modulus of steel is $2 \times 10^{11} \text{ Nm}^{-2}$

باادب شاگرد ہی ہمیشہ علم سے پورا پورا مستفید ہوتا ہے۔ (حضرت بابا فرید الدین گنج شکرؒ)

(سٹی اکیڈمی سرگودھا)

پوزیشن ہولڈر سٹوڈنٹس کا واحد انتخاب

9th & 10th

ہو نہار طلباء و طالبات میٹھ، فزکس، کیمسٹری، بیالوجی، کمپیوٹر، انگلش کورس کی اپنے سکول سے پہلے تکمیل کے لیے ہمارا انتخاب کرتے ہیں۔ کورس کی تکمیل کے بعد بورڈ کی نئی سکیم کے مطابق تیار کردہ ٹیسٹ کی مدد سے کورس کی دہرائی۔ ان ٹیسٹ سے گزرنے والا سٹوڈنٹ بورڈ کے امتحان میں یقینی %90 پلس مارکس حاصل کر سکتا ہے۔

(خوشخبری)

کلاس ہشتم اور نہم کے سالانہ امتحان میں %90 سے زائد مارکس حاصل کرنے والوں کے لیے فری ایجوکیشن۔ فری ایجوکیشن کی نشستیں محدود ہیں۔

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